Production Efficiency OfHoaloc-Mango Gardeners In The Southern Vietnam

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Abstract - A structured questionnaire was used to collect data with 184 observations of the cooperative farmer group and 230 that of the non-cooperative farmer group. The results indicated that technical efficiency mean of the cooperative grower group was greater than that of the non-cooperative grower group in seasons 2, and 3, while this figure of the cooperative farmer category was lower than that of the non-cooperative farmer category in the first season. Additionally, the positive determinants of technical efficiency in the cooperative farmer group were the age and plant density in season 1, the wrapping bag in seasons 1, and 2, the land area in season 1, and 3, and the credit access and market access in season 3. Meanwhile, the negative factors were the payment for agro-input wholesaler and classifying sale in season 1, the credit access in season 2, the age, education, farming experience and plant density in season 3. In the non-cooperative farmer group, the positive determinants were the land area in seasons 2, and 3, the credit access in season 2, and the plant density in season 3. However, the negative elements were the wrapping bag in seasons 1, and 2, the age, education, farming experience, market access and land area in season 1, and the classifying sale in season 2.
Key words - Technical efficiency, HoaLoc-mango, cooperative, non-cooperative

I.INTRODUCTION

There are many different types of mango in Vietnam, but the most famous is probably Mangos from a small town of HoaLoc, a small town from the Mekong delta in southern Vietnam, particularly in the province of Tien Giang. The HoaLoc mango is usually weight between 350 to 450 grams and it has an oval shape and the golden yellow skin when ripe. The pulp is also bright and smooth yellow. The HoaLoc mango is fleshy, less fibrous, very sweet and aromatic and it is widely available everywhere in Vietnam.

In Vietnam, mango has been grown in all provinces of the county, in which in the southern Vietnam has considered center for mango production in Vietnam. The southern Vietnam has provided to international and domestic market about fresh mango 552,000 ton/year with area nearly 51,500 ha [10]. The household survey carried out by [14] that indicated average household mango cultivation area of 0.68 hectares per. Mango cultivation was primarily small farmer's activity. It is difficult for market signals relating to demand, varieties, quality and food safety to be translated farmers, most sell to local collectors and wholesalers with few incentives to improve quality, limited awareness of market demand and quality requirements, poor technical skills and difficulties in funding investment. The Vietnamese government has therefore been promoting what is called the "large field" program under which farmers are encouraged to organize together as cooperatives and groups and establish long term relationships with companies through contracts involving the supply of inputs, provision of extension advice by company agents and purchase of farmers' produce at agreed prices.

Hence, the objective of this study paid particular attention on determinants of efficiency associated with structural variables that would influence efficiency differentials among production units [6], [9], [21], [23]. This brought in formulating the policy measures to alleviate different constraints in the HoaLoc-mango production of various seasons of year in the southern Vietnam. The study specifically found out effective disparities among HoaLoc-mango seasons of year, the technical relationships between inputs and output in mango production, determinants of technical efficiency in HoaLoc-mango production between non-cooperative and cooperative farmer groups.

II. METHODOLOGY

2.1 Sampling Techniques

South-eastern region and Mekong Delta region were purposively selected for the study because of its comparative advantage in mango production system with accounting for 75% volume and making up 72% area in Vietnam. Dong Nai province of south-eastern region and Dong Thap, Tien Giang, HauGiang, and Vinh Long provinces of Mekong Delta were chosen because Dong Nai province occupied approximately 55% volume and making up 54% area in south-eastern region and 4 provinces accounted for about 67% volume and making up 55% area in Mekong Delta [10]. Simple random technique was used to select 184 sampling observations of cooperative farmer group (53 for season 1; 61 for season 2 and 70 for season 3), and 230 sampling observations of non-cooperative farmer group (67 for season 1; 85 for season 2 and 78 for season 3).

2.2Empirical Model

The Cobb-Douglas (CD) production function was found to be an adequate representation of the data. The stochastic frontier model is defined by:

$$lnYi = \beta o + \beta 1 lnX1 + \beta 2 lnX2 + \beta 3 lnX3 + \beta 4 lnX4 + \beta 5 lnX5 + Vi - Ui$$

The translog production function is alternatively defined as follows:

$$ln\ Yi = \beta o + \beta 1 lnX1 + \beta 2 lnX2 + \beta 3 lnX3 + \beta 4 lnX4 + \beta 5 lnX5 + 0.5\beta 6(lnX1)^2 + 0.5\beta 7 ln(lnX2)^2 + 0.5\beta 8 ln(lnX3)^2 + 0.5\beta 9 ln(lnX4)^2 + 0.5\beta 10 ln(lnX5)^2 + \beta 11 lnX1 lnX2 + \beta 12 lnX1 lnX3 + \beta 13 lnX1 lnX4 + \beta 14\ lnX1 lnX5 + \beta 15 lnX2 lnX3 + \beta 16 lnX2 lnX4 + \beta 17 lnX2 lnX5 + \beta 18 lnX3 lnX4 + \beta 19 lnX3 lnX5 + \beta 20 lnX4 lnX5 + Vi - Ui$$

Where:

ln= logarithm to base e
Yi = output of HoaLoc-mango (kg);
βo = constant or Intercept of the model;
$\beta 1 - \beta 20$ = coefficients to be estimated;
X1 = quantity of pesticide (liters);
X2 = quantity of fungicide (liters);
X3 = quantity of fertilizer_root (kg);
X4 = quantity of fertilizer_leaf (kg) (spraying on mango leaves to stimulate mango flower);
X5 = family and hired labour (man-days);
Vi= random error term;
Ui= technical inefficiency effect predicted by the model and the subscript *i*indicate the *ith*farmer in the sample.

The determinants of technical efficiency of mango farmers in line with [19] were modeled following specific characteristic of farmers in the study area. From equation the component is specified as follows:

$$u_i = \alpha_0 + \sum_{r=1}^{10} \alpha_r Z_r + \mathbf{k}$$

Where:

u_i = technical inefficiency of i-th farmer,
$\alpha_0$andα_r = parameters to be estimated,
k = Truncated random variable.
Z_1 = Farmer`s age (year),
Z_2 = Level of education (years spent in acquiring formal education)

Z_3 = Farming experience (year)
Z_4 = Credit access (access =1, no access = 0)
Z5 = Payment for agro-input wholesaler (ending of crop =1, payment immediately =0)
Z_6 = Wrapping bag (wrap = 1, no wrap =0)
Z_7 = Market access (access = 1, no access = 0)
Z_8 = Classifying sale (classification =1, no classification = 0)
Z_9 = Plant density (plants/ha)
Z_{10} = Land area (cong = 1,000 m^2)

The estimates for all the parameters of production functions and inefficiency model were obtained by maximizing the likelihood function on the FRONTIER 4.1 program.

III. EMPIRICAL RESULTS

3.1 Estimation Procedure

To select the lead functional form for the data, hypothesis test base on the generalized likelihood ratio test (LR) was conducted. = - 2 {log [L (H0) – log [L (Ha)]} formula was used to carry out the likelihood ratio test. The null hypothesis was the statement that the Cobb-Douglas production function was the best fit for the data. Result indicated that it was rejected the null hypothesis in five cases because lambda values $\lambda 1$=47.74, $\lambda 2$=30.82, $\lambda 3$=42.96, $\lambda 4$=42.42, $\lambda 5$ =35.50 were greater than critical value (25.0) at 5% level of significance, meaning that Translog form was the best functional form for the data (Table 2). One case accepted the null hypothesis with$\lambda 6$= 19.38 was lower than critical value (25.0) at 5% level of significance, showing that Cobb-Douglas form was the best functional form for the data (Table 1).

Table-1Generalized likelihood ratio test for stochastic production model.

Season	**Null Hypotheses**	**Log likelihood (H_0)**	**Log likelihood (H_1)**	**Test statistic (λ)**	**Degree of Freedom**	**Critical value (5%)**	**Decision**
Coop							
Season 1	Cobb-Douglas is the best fit	-59.34	-35.47	47.74	15	25	Rejected
Season 2	Cobb-Douglas is the best fit	-75.73	-60.32	30.82	15	25	Rejected
Season 3	Cobb-Douglas is the best fit	-74.09	-52.61	42.96	15	25	Rejected
Non-coop							
Season 1	Cobb-Douglas is the best fit	-74.81	-53.60	42.42	15	25	Rejected
Season 2	Cobb-Douglas is the best fit	-106.56	-88.81	35.50	15	25	Rejected
Season 3	Cobb-Douglas is the best fit	-83.30	-73.61	19.38	15	25	Not rejected

** Critical values with asterisk are taken from Kodde and Palm (1986). For these variables the statistic λ is distributed following a mixed χ2 distribution.*

The expected parameters and the related statistical test results obtained from the analysis of the maximum likelihood estimates (MLE) of the Translog and Cobb-Douglas based on stochastic frontier production function for HoaLoc-mango farmers in the southern Vietnam were presented in Table 3. The sigma squares (σ^2) of cooperative farmer category were 0.52 in season 1; 1.42 in season 2; and 1.40 in season 3 and that of non-cooperative farmer category were 1.81 in season 1; 0.95 in season 2; and 0.62 in season 3, which were found to be significantly different from zero, suggested a good fit of the models and the correctness of the specified distributional assumptions respectively.

Furthermore, the gamma parameters of cooperative farmer group (γ_1=0.9999, γ_2=0.9999, γ_3=0.9999) were quite high and significant at 1% level of probability, implying that 76.88% of variation in season 1, and 99.99% of variation in season 2 and season 3, which resulted from technical efficiency of the sampled farmers rather than random variability. Similarly, the gamma parameters of non-cooperative farmer group (γ_1=0.9999, γ_2=0.9999, γ_3=0.5444) were significant at 1% and 10% level. This revealed that there were 99.99%; 99.99% and 54.44% in technical efficiency to be explained by given variables in season 1, season 2 and season 3 respectively.

Table -2MLE estimates for SFA model of cooperative and non-cooperative farmer group

Variables	**Season 1**		**Season 2**		**Season 3**	
	Coop	***Non-Coop***	***Coop***	***Non-Coop***	***Coop***	***Non-Coop***
	Coef.	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*
Dependent Variable (Y: Ln Yield(kg))						
Constant	8.143***	2.099***	15.178***	11.211***	4.477***	7.801***
(X_1) Ln pesticide (liters)	-4.284***	-0.494	-0.282	1.974***	-0.115	-0.073
(X_2) Ln fungicide (liters)	4.476***	-1.100***	0.516	1.030	0.055	0.067
(X_3) Ln fertilizer_root (kg)	2.603***	1.232**	-1.810**	-1.544***	-0.751***	0.077*
(X_4) Ln fertilizer_leaf (kg)	2.312***	0.136	-0.342	0.171	-0.159	-0.003
(X_5) Ln labour (man day)	-7.056***	1.706***	-0.294	-1.226	2.552***	0.025
½ *Ln $(X1)^2$	-1.093***	0.024	-0.179	0.328*	-0.142**	
½ *Ln $(X2)^2$	-0.197***	-0.204***	-0.129	-0.648***	-0.252***	
½ *Ln $(X3)^2$	0.181***	-0.312***	-0.113	-0.065	-0.084***	
½ *Ln $(X4)^2$	0.005	0.469***	-0.502**	-0.056	0.143***	
½ *Ln $(X5)^2$	1.976***	-1.151***	-0.649	0.209	-1.049***	
Ln (X1)*Ln(X2)	0.385***	-0.043	-0.040	0.058	-0.138***	
Ln (X1)*Ln(X3)	0.430**	0.093***	0.050	0.008	-0.050*	
Ln (X1)*Ln(X4)	0.324*	0.196***	0.249	-0.088	0.002	
Ln (X1)*Ln(X5)	0.533***	-0.137***	0.007	-0.659***	0.239***	
Ln (X2)*Ln(X3)	-0.003	-0.157**	0.052	-0.125*	-0.075***	
Ln (X2)*Ln(X4)	-0.887***	-0.251***	-0.436***	0.237	-0.016	
Ln (X2)*Ln(X5)	-0.542***	0.859***	0.150	0.234	0.267***	
Ln (X3)*Ln(X4)	-0.784***	0.041	0.194*	0.111	0.064***	
Ln (X3)*Ln(X5)	-0.545***	0.154**	0.338	0.497***	0.293***	
Ln(X4) *Ln(X5)	1.084***	-0.128	0.323	-0.389	-0.038*	
Diagnostic Statistics						
Sigma square (σ^2)	0.5209	1.8137	1.4285	0.9537	1.4043	0.6189
Gamma (γ)	0.9999***	0.9999***	0.9999***	0.9999***	0.9999***	0.5444*
Log-likelihood function	-35.475	-53.604	-60.329	-88.809	-52.616	-83.309
Number of observations (N)	53	67	61	85	70	78

Source: Field Survey Data, 2018

** Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level*

Regarding season 1, the analysis of the estimated model of cooperative producer group pointed out that the coefficient of fungicide, fertilizer (root) and fertilizer (leaf) were positive and statistically significant at 1% level while the coefficient of pesticide and labour were negative at 1% significant level. The positive relationship of fungicide, fertilizer (root) and fertilizer (leaf) with yield suggested that a 1% increase in fungicide, fertilizer (root) and fertilizer (leaf) will result to 4.476%, 2.603% and 2.312% respectively increase in yield of HoaLoc-mango farmers. The coefficients of thesquare term for fertilizer (root) and labour were positively and highlysignificant at 1% level of probability, showing adirect relationship with yield but the coefficients of interaction between fungicide and labour was negative, indicating increase in the combination will decrease yield of HoaLoc-mango. Meanwhile, the analysis of the estimated model of non-cooperative producer group revealed that coefficient of fungicide and labour were positive at significant 5%, 1% level respectively whereas the coefficients of pesticide and fertilizer (root) were negative at significant 1% level. The coefficients of thesquare term for fungicide, fertilizer (root), fertilizer (leaf) and those of interactions between pesticide and fungicide, pesticide and fertilizer (root), pesticide and labour, fertilizer (leaf) and labourwere positively significant at the conventionalsignificance levels. This implied that these combinations would bring higher productivity for growers producing HoaLoc-mango.

Turning to season 2, fertilizer (root) variable of cooperative farmer category were negative and significant at 5% with coefficient of 1.810. Alternatively a 1% rise in fertilizer (root) will lead to 1.810% decline in yield of HoaLoc-mango production. Analogously, the coefficients of thesquare term of fertilizer (leaf) was negative, showing increase of the variable in production was limited to output. Additionally, the coefficient ofinteraction between fungicide and fertilizer (leaf) was negative and significant at 1% level, implying that increases in the combinations lead to decrease in output of HoaLoc-mango while the coefficient ofinteraction between fertilizer (root) and fertilizer (leaf) rose productivity of HoaLoc-mango. For non-cooperative farmer category, pesticide variable was positive and significant at 1% level with coefficient of 1.974 whereas the coefficients of fertilizer (root) were negative at significant 1% level. The coefficient of thesquare term for pesticide was positive influence on yield of HoaLoc-mango at 10% significant level but that of fungicide affected negatively at 1% level. Moreover, the coefficient ofinteraction between pesticide and labour, fungicide and fertilizer (root) were negatively significant at 1% and 10% level of probability, implying that the more pesticide and labour, fungicide and fertilizer (root), the lower yield of HoaLoc-mango production. By contrast, increase in fertilizer (root) and labour will improve productivity of HoaLoc-mango at significant 1% level.

For season 3, input variable of labour in cooperative grower category played important and positive role in impacting on HoaLoc-mango production with high coefficient of 2.552 at 1% level of significance while fertilizer (root) variable was negatively significant at 1% level with coefficient of 0.751. In addition, the coefficient of thesquare term for pesticide, fungicide, fertilizer (root) and labour were negative influence on yield of HoaLoc-mango whereas that of fertilizer (leaf) affected positively. Furthermore, the coefficients of interaction between pesticide and labour, fungicide and labour, fertilizer (root) and fertilizer (leaf), fertilizer (root) and laour were positively significant at 1% level of probability contrasting with that of interaction between pesticide and fungicide, pesticide and fertilizer (root), fungicide and fertilizer (root), fertilizer (root) and laour being negative and significant effect on productivity of HoaLoc-mango at the conventionalsignificance levels. For non-cooperative grower category, fertilizer (root) was positively significant at 10% level. It meant that a 1% increase in pesticide would result in 0.077% increase in productivity of HoaLoc-mango.

3.2TechnicalInefficiencyFunction

The analysis results of Table 3 showed that factors influencing technical efficiency of HoaLoc-mango farmers in the southern Vietnam among three seasons. The purpose of estimating to determine the relationship between technical inefficiency and household characteristics.

Table -3MLE of the determinants of technical inefficiency score

Variables	**Season 1**		**Season 2**		**Season 3**	
	Coop	***Non-Coop***	***Coop***	***Non-Coop***	***Coop***	***Non-Coop***
	Coef.	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*
Constant	1.942***	-10.517***	-0.495	0.766	-3.439***	2.940**
(Z_1) Age	-0.025**	0.125***	0.010	0.016	0.057***	-0.006
(Z_2) Education	0.040	0.134*	-0.017	0.097	0.127*	0.044
(Z_3) Farming experience	-0.015	0.010*	-0.015	-0.041	0.037*	-0.039
(Z_4) Credit access	-0.629	-0.910	1.510**	-1.075**	-3.703***	-0.108
(Z_5) Payment for agro- input	1.424***	-0.269	-0.060	1.018**	-0.450	0.306
(Z_6) Wrapping bag	-0.520***	1.000*	-1.908***	0.753*	0.000	0.170
(Z_7) Market access	0.242	1.642***	1.320	-0.407	-1.295*	0.333

(Z_8) Classifying sale	1.247***	-1.074	0.552	1.265***	-0.048	-0.242
(Z_9) Plant density	-0.001**	-0.001	0.003	-0.001	0.002*	-0.003**
(Z_{10}) Land area	-0.107**	0.163***	-0.045	-0.225***	-0.099**	-0.229**

Source: Field Survey Data, 2018
** Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level*
***Note:** A negative sign in the parameters of the inefficiency function means that the associated variable had a positive effect on economic efficiency, and vice versa.*

In season 1, the parameter estimate pointed out that age, wrapping bag and land area variables were statistical meaning both cooperative and non-cooperative grower profiles, in which these variables were positive and significant variables on technical efficiency of cooperative gardener category contrasting with being negative impact on that of non-cooperative gardener category. The finding of age in cooperative farmer group was in conformity with some earlier studies of [15], [17]; however, the result of age in no-cooperative farmer group agreed with the result of [2], [4], [8], [22]. Furthermore, in non-cooperative farmer profile experienced negative impact of education, farming experience and market access at significant 10%, 10% and 1% level respectively. The research result of education was in agreement with some earlier study [20] but in disagreement with the studies of [5], [8], [11], [12], [16], [24], [25] who found a strong and positive relationship between educational level and technical efficiency of the farmer. For finding of farming experience in non-cooperative grower group, the result was against with some earlier researches [1], [7], [16]. The studies stated a positive relationship between technical efficiency and farming experience.

In season 2, the coefficient of wrapping bag was positive and significant at 1% level in technical efficiency of cooperative farmer group but was negative and significant at 10% level in that of non-cooperative farmer group. Meanwhile, credit access variable of in cooperative grower profile was negative influence on technical efficiency. The similar findings were obtained by [8], [12], [18]. However, the variable was positive in technical efficiency of non-cooperative grower profile. The result concurred with the studies of [5], [13]. Besides, coefficient of classifying sale in non-cooperative grower profile was negative and significant at 1% level which showed that farmers sold mango with classifying form reaching lower productivity compared with selling non-classification.

In season 3, technical efficiency of cooperative farmer profile was undergone negatively and significantly from three variables comprising age, education and farming experience with coefficient of 0.057; 0.127; and 0.037 respectively. On the other hand, credit access and market access in cooperative grower profile were found positive and significant effect on farmers' technical efficiency at the conventional significance levels. The result of credit access was analogous with previous studies of [5], [13].

3.3Technical Efficiency Distribution

Looking at season 1, the analysis of research indicated that technical efficiency ranged from 0.0717-0.9998 with a mean of 0.5041 in cooperative producer category, and from 0.0414-0.9985 with a mean of 0.5476 in non-cooperative producer category. This displayed that the technical efficiency mean of cooperative producer category was lower than that of non-cooperative producer category. The result presented technical efficiency gap of about 49.59% of cooperative producer category, and 45.24% of non-cooperative producer category. This implied that the average farmer in the study area could increase HoaLoc-mango productivity by 49.59% and 45.24% by improving their technical efficiency. The implication of the result showed that the average mango farmer of cooperative and non-cooperative farmer groups required 49.57% ((1 – 0.5041/0.9998)*100) and 45.15% ((1 – 0.5476/0.9985)*100) respectively cost saving to attain the status of the most efficient mango grower of production, while the least performing of cooperative and non-cooperative farmer groups needed 92.83% ((1 – 0.0717/0.9998)*100) and 95.85% ((1 – 0.0414/0.9985)*100) respectively cost saving to become the least efficient mango grower in the southern Vietnam.

Table -4Efficiency level distribution of technical efficiency scores in the southern Vietnam

Technical efficiency level	**Season 1**		**Season 2**		**Season 3**	
	Coop	***Non-Coop***	***Coop***	***Non-Coop***	***Coop***	***Non-Coop***

	%	%	%	%	%	%
<0.1	5.66	4.48	14.75	28.24	7.14	1.28
0.1-<0.2	15.09	17.91	11.48	20.00	17.14	8.97
0.2-<0.3	3.77	5.97	9.84	14.12	10.00	17.95
0.3-<0.4	20.75	8.96	11.48	3.53	11.43	19.23
0.4-<0.5	9.43	10.45	9.84	7.06	7.14	8.97
0.5-<0.6	7.55	5.97	8.20	2.35	1.43	11.54
0.6-<0.7	7.55	7.46	1.64	3.53	7.14	7.69
0.7-<0.8	7.55	10.45	6.56	4.71	7.14	12.82
0.8-<0.9	7.55	8.96	9.84	2.35	5.71	11.54
0.9-<1.0	15.09	19.40	16.39	14.12	25.71	0.00
1.0	0.00	0.00	0.00	0.00	0.00	0.00
Number of obs (N)	53	67	61	85	70	78
Minimum	0.0717	0.0414	0.0278	0.0140	0.0430	0.0477
Maximum	0.9998	0.9985	0.9996	0.9997	0.9945	0.8841
Mean	0.5041	0.5476	0.4755	0.3477	0.5310	0.4757
Std. deviation	0.2947	0.3111	0.3274	0.3252	0.3358	0.2309

Source: Field Survey Data, 2018

The outstanding feature of season 2 was technical efficiency of cooperative farmer group to achieve between 0.0278 and 0.9996 with the mean technical efficiency of 0.4755 and that of non-cooperative farmer group to acquire from 0.0140 to 0.9997 with the mean technical efficiency of 0.3477. This depicted that the technical efficiency mean of cooperative producer category was greater than that of non-cooperative producer category. The average technical efficiency indexes of 0.4755 and 0.3477 proposed that an average mango farmer of cooperative and non-cooperative farmer groups in the southern Vietnam had the capacity to rise technical efficiency in mango production by 52.45% and 65.23% to obtain the maximum possible level. Thus, the sample frequency distribution indicated that there were efficiency gap but with scope for improvement in mango production among mango farmers. This pointed that average mango farmer of cooperative farmer group and non-cooperative farmer group could experience a cost saving of 52.43% ((1 – 0.4755/0.9996)*100) and 65.22% ((1 – 0.3477/0.9997)*100) respectively whereas the worst efficient farmer of cooperative farmer group and non-cooperative farmer group proposed an improvement in technical efficiency of 97.22% ((1 – 0.0278/0.9996)*100) and 98.60% ((1 – 0.0140/0.9997)*100) respectively.

At the season 3, results also showed that the technical efficiency mean of cooperative grower category (53.10%) was greater than that of non-cooperative grower category (47.57%). The figure indicated that there were efficiency gap but with scope for improvement in mango production among mango farmers. The implication of the result revealed that average mango farmer of cooperative and non-cooperative farmer groups could experience a cost saving of 46.60% ((1 – 0.5310/0.9945)*100) and 46.19% ((1 – 0.4757/0.8841)*100) respectively while the least efficient farmer of cooperative farmer group and non-cooperative farmer group proposed an enhancement in technical efficiency of 95.68% ((1 – 0.0430/0.9945)*100) and 94.60% ((1 – 0.0477/0.8841)*100) respectively.

IV. CONCLUSIONS

The result revealed that technical efficiency mean of cooperative farmer category was lower than that of non-cooperative farmer category in season 1. However, technical efficiency mean of cooperative grower group was greater than that of non-cooperative grower group in season 2 and season 3. Results from the study showed thatadjustments in the input factors could lead to improveproduction of HoaLoc-mango in the southern Vietnam.

Furthermore, empirical findings indicated that the positive determinants of technical efficiency of cooperative farmer group were age and plant density in season 1, wrapping bag in season 1 and season 2, land area in season 1 and season 3, and credit access and market access in season 3 while the negative factors were payment for agro-input wholesale and classifying sale in season 1, credit access in season 2, age, education, farming experience and plant density in season 3. Turning to non-cooperative farmer group, the positive determinants of technical efficiency were land area in season 2 and season 3, credit access in season 2, and plant density in season 3 whereas the negative elements were wrapping bag in season 1 and season 2, age, education, farming experience, market access and land area in season 1, and classifying sale in season 2.

ACKNOWLEDGEMENTS

With this letter, I confirm that my article has been carried out from data source of project in Vietnam with the title “Value chain development of Vietnamese mango fulfilling requirement for domestic and international markets”(2017-2020, code: KHCN-TNB.ĐT/14-19/C14) that I has been a key member to be responsible for content of mango value chain analysis. Particularly, I would like to thank you financial support from program “Technology and science program for sustainable development in south-western region”.The project belongs to “The national technology and science program in Vietnam” from Ministry of technology and science in Vietnam. I would like to publish my article in order to share my result. Should I be of any assistance, or should you need more information, please do not hesitate to contact with me.

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